Pressure Sensitive Paint Applied to Flexible Models

Completed Technology Project (2012 - 2012)

Project Introduction

One gap in current pressure-measurement technology is a high-spatial-resolution method for accurately measuring pressures on spatially and temporally varying wind-tunnel models such as Inflatable Aerodynamic Decelerators (IADs), parachutes, and sails. Conventional pressure taps only provide sparse measurements at discrete points and are difficult to integrate with the model structure without altering structural properties. Pressure Sensitive Paint (PSP) provides pressure measurements with high spatial resolution, but its use has been limited to rigid or semi-rigid models. Extending the use of PSP from rigid surfaces to flexible surfaces would allow direct, high-spatial-resolution measurements of the unsteady surface pressure distribution. Once developed, this new capability will be combined with existing stereo photogrammetry methods to simultaneously measure the shape of a dynamically deforming model in a wind tunnel. Presented here are the results and methodology for using PSP on flexible surfaces.

To make PSP measurements on a flexible model, the paint must adhere to the model without cracking as the shape of the model changes. In addition, the paint must not alter the structural or aerodynamic properties of the model. Because pressure-sensitive paints can be brittle, they will likely crack if applied as a continuous sheet. This problem will be addressed by applying the PSP as a dense distribution of speckles. Each speckle will yield a pressure measurement and also serve as a target for photogrammetry. Another requirement is that the brightness of the paint must respond fast enough to capture changes in pressure due to model shape changes. Paints with response times as short as 1 ms are commercially available. This is fast enough to capture expected unsteadiness of sub-scale flexible models (tens of Hz). For time-resolved, unsteady measurements, the paint must be bright enough to produce usable images from a single flash. For periodic unsteadiness, images may be phase-averaged over many cycles to improve Signal-to-Noise-Ratio (SNR). Brightness can be increased by increasing the intensity of the incident illumination. To implement the PSP/photogrammetry system in a research wind tunnel, a paint-speckled flexible model will be imaged from at least two directions by high-speed, synchronized cameras. The model will be illuminated by a pulsed light source synchronized with the cameras, and the local pressure at each PSP speckle will be determined from the change in brightness of the speckle in successive images acquired as the luminescence decays. The object-space coordinates of each speckle, and thus the shape of the test article, will be determined by conventional photogrammetric methods.

Anticipated Benefits

After flexible PSP is demonstrated in a small research tunnel, the technique will be scaled up for use in larger production wind tunnels. This new measurement capability will benefit all four projects in the Fundamental

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Center Innovation Fund: ARC CIF

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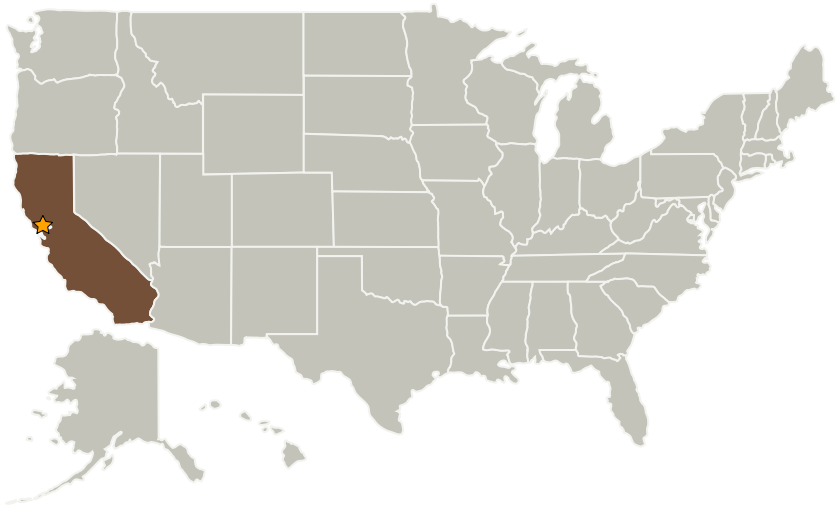
Aeronautics program (Fixed Wing, Rotary Wing, High Speed and Aeronautical Sciences). This added capability would directly benefit the development of flexible aerodynamic decelerators, both inflatable and mechanical, which are currently being studied by ESMD.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California
University of California-Santa Cruz	Supporting Organization	Academia	Santa Cruz, California

Primary U.S. Work Locations
California

Project Management

Program Director:
Michael R Lapointe

Program Manager:
Harry Partridge

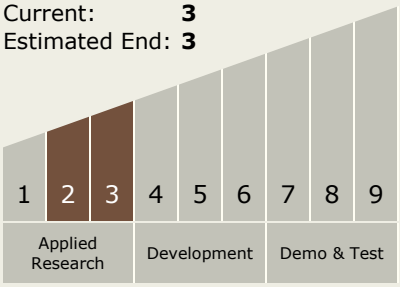
Project Manager:
Edward T Schairer

Principal Investigator:
Edward T Schairer

Co-Investigator:
Laura K Kushner

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  - TX15.1 Aerosciences
    - TX15.1.8 Ground and Flight Test Technologies